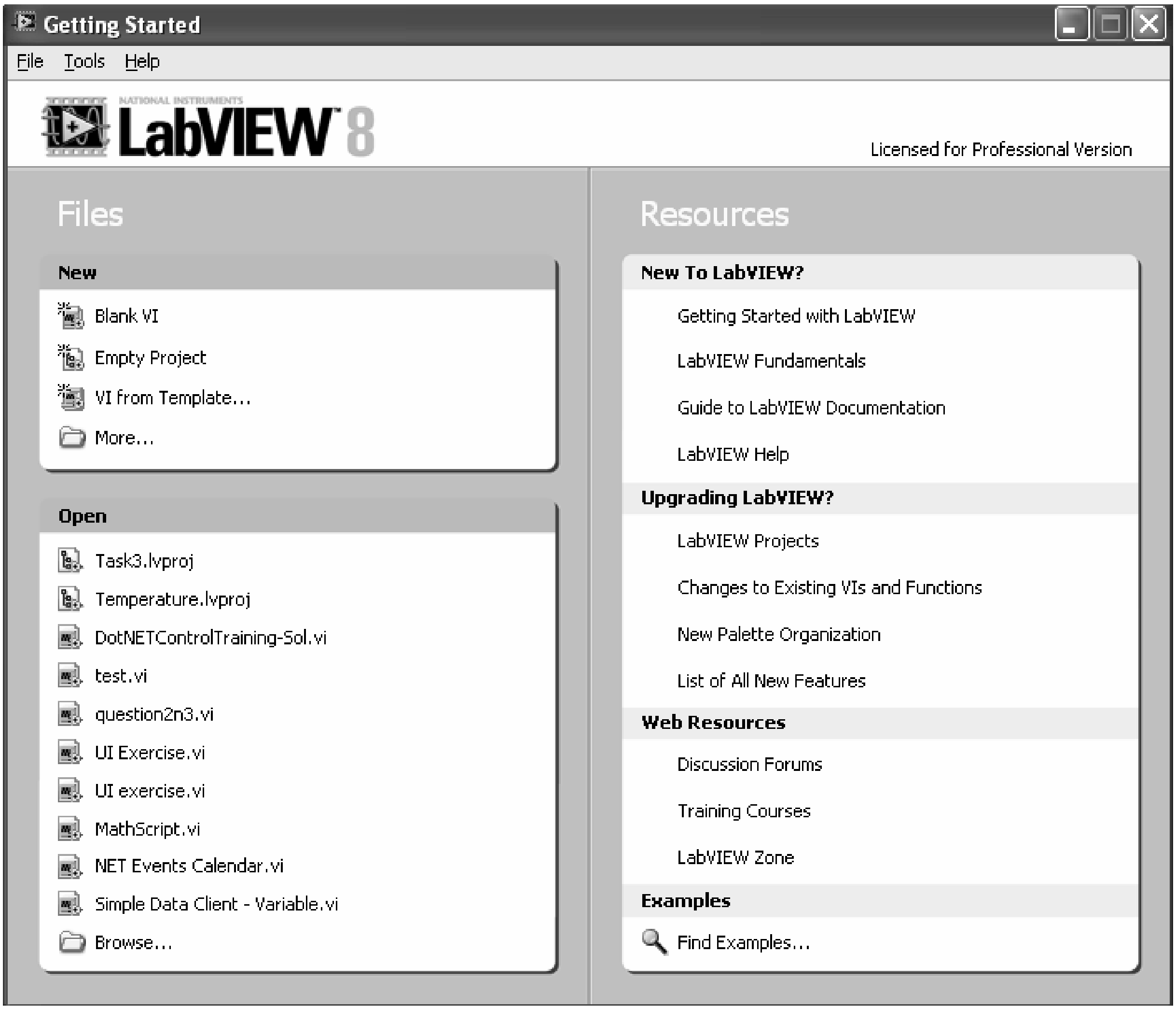
Exercise 2a: Data Acquisition in LabVIEW

In this exercise, you will use the DAQ Assistant to set up a channel and configure a virtual thermocouple measurement.

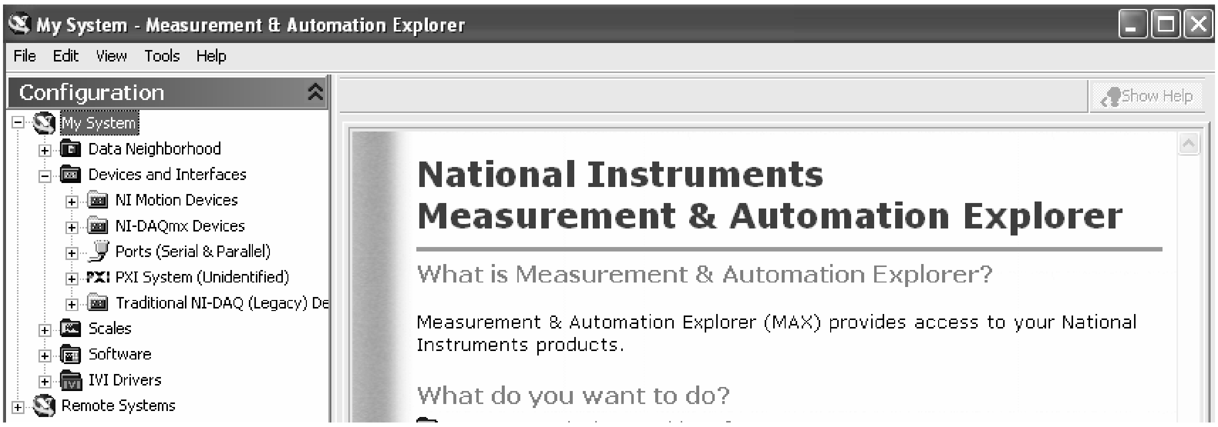
1. Click the **LabVIEW** icon on your desktop toolbar. If you already have a VI open, choose **File»Close** to return to the main LabVIEW start menu. A splash screen like the following appears.



2. Create a new **Blank VI** from the LabVIEW splash screen.

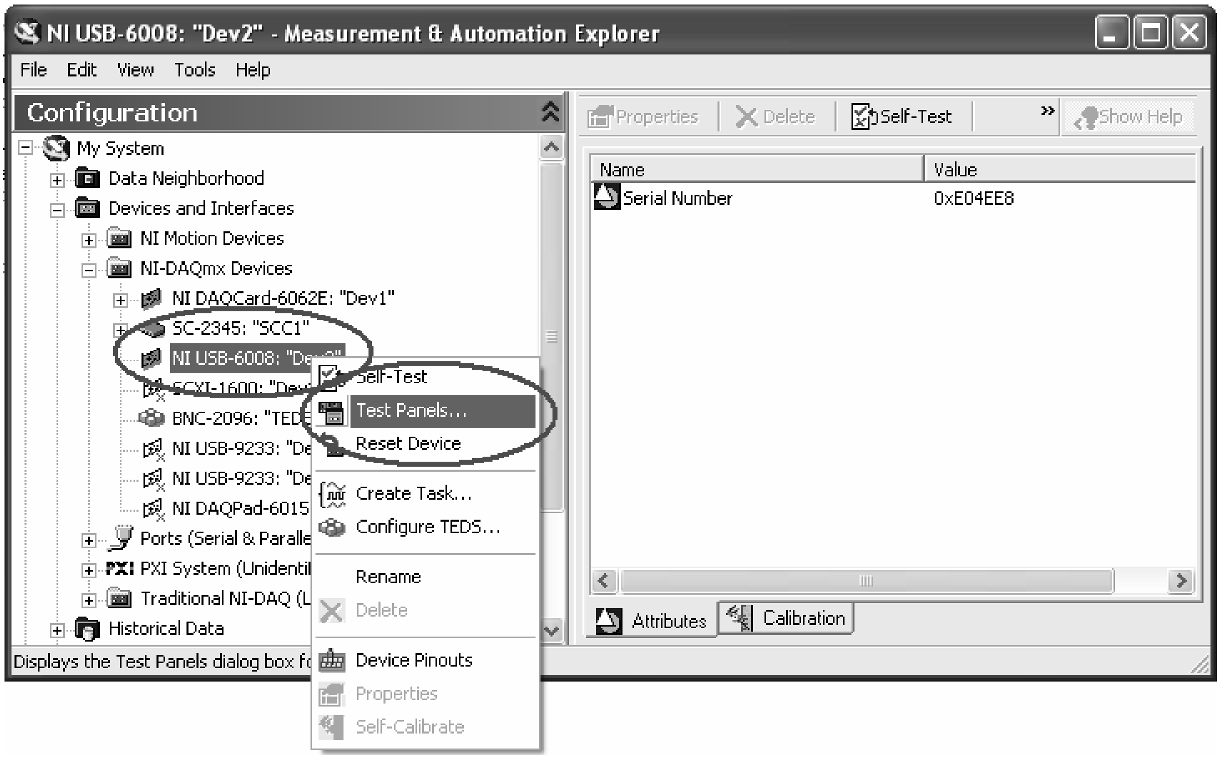
3. First we will examine Measurement & Automation Explorer (MAX). MAX allows you to test, troubleshoot, and verify installation of your National Instruments hardware without any programming. To open MAX, select **Tools»Measurement & Automation Explorer** from the menu bar in LabVIEW.

4. Double-click the icon on the left labeled **Devices and Interfaces**. This category contains all of the different devices and interfaces which you can currently communicate. Your device list should resemble the following screen.

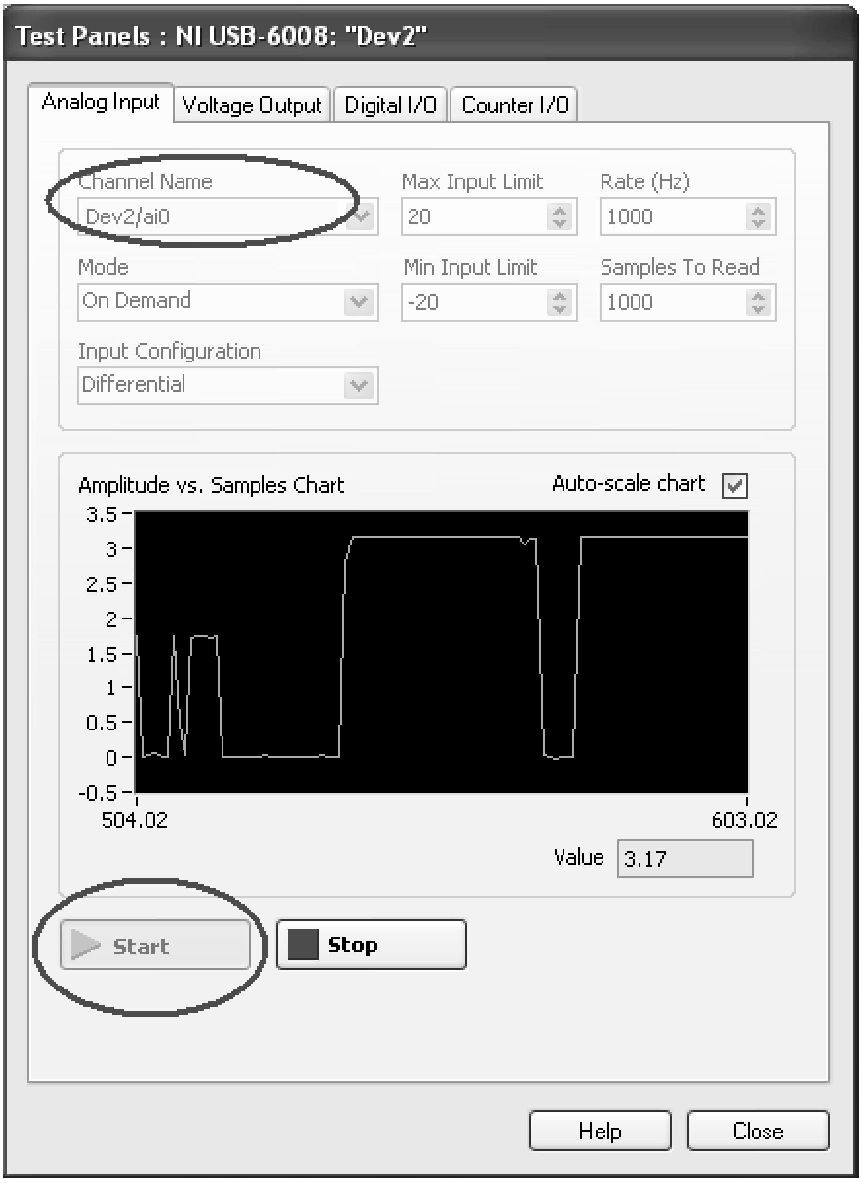


5. Click **NI-DAQmx Devices**. You will see a Data Acquisition (DAQ) card listed. The model should be etiher NI USB-6008 or NI USB-6009. If you do not see a DAQ card, select **View»Refresh** to have MAX search for the devices installed on your computer.

   Right-click the DAQ card and select **Test Panels**. This will bring up a window that will allow you to perform the different data acquisition tasks that are available on your board.



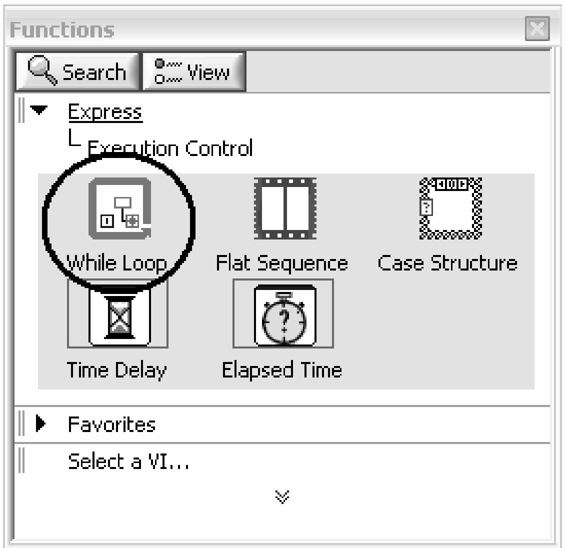
6. Click on Start and you can see a real-time Chart of the signals read by the DAQ card's selected channel <Channel Name>. The USB-6008/9 has 8 Single Ended Channels for Voltage Input. If the <Input Configuration> you have chosen is Differential, the Single Ended Channels will be paired up. eg. <AI0-AI4> will form up <AI0+-AI0->, <AI1-AI5> will become <AI1+-AI1-> etc…

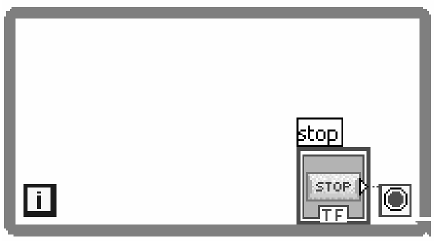


7. You should see a straight line if the signal you want to measure is wired up correctly. You may want to try to 'tap' the wires on the connector instead of fastening it. In this case you will see something like the above screenshot because the USB-6008/9 is reading the signals in REAL-TIME. This shows the ability to use MAX as a troubleshooting and testing tool before you begin programming to ensure your hardware is set up properly.

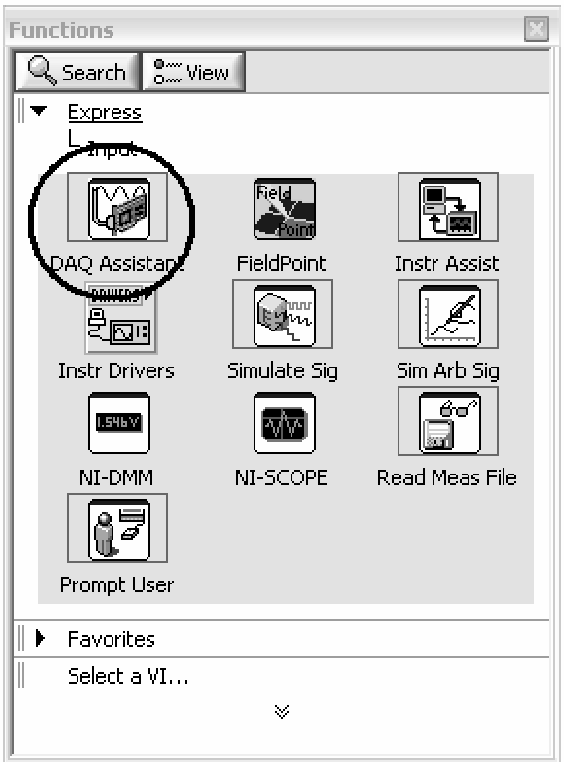
8. Click **Stop** on the Test Panel when you are finished. Close the Test Panel window and Measurement & Automation Explorer and return to the LabVIEW Block Diagram.

9. Right-click the Block Diagram to bring up the functions palette. Place a While Loop on your Block Diagram by selecting **Express»Execution Control»While Loop**.





9. Place a **DAQ Assistant** Express VI inside your While Loop. This is located in the **Input** subpalette of the Functions palette.

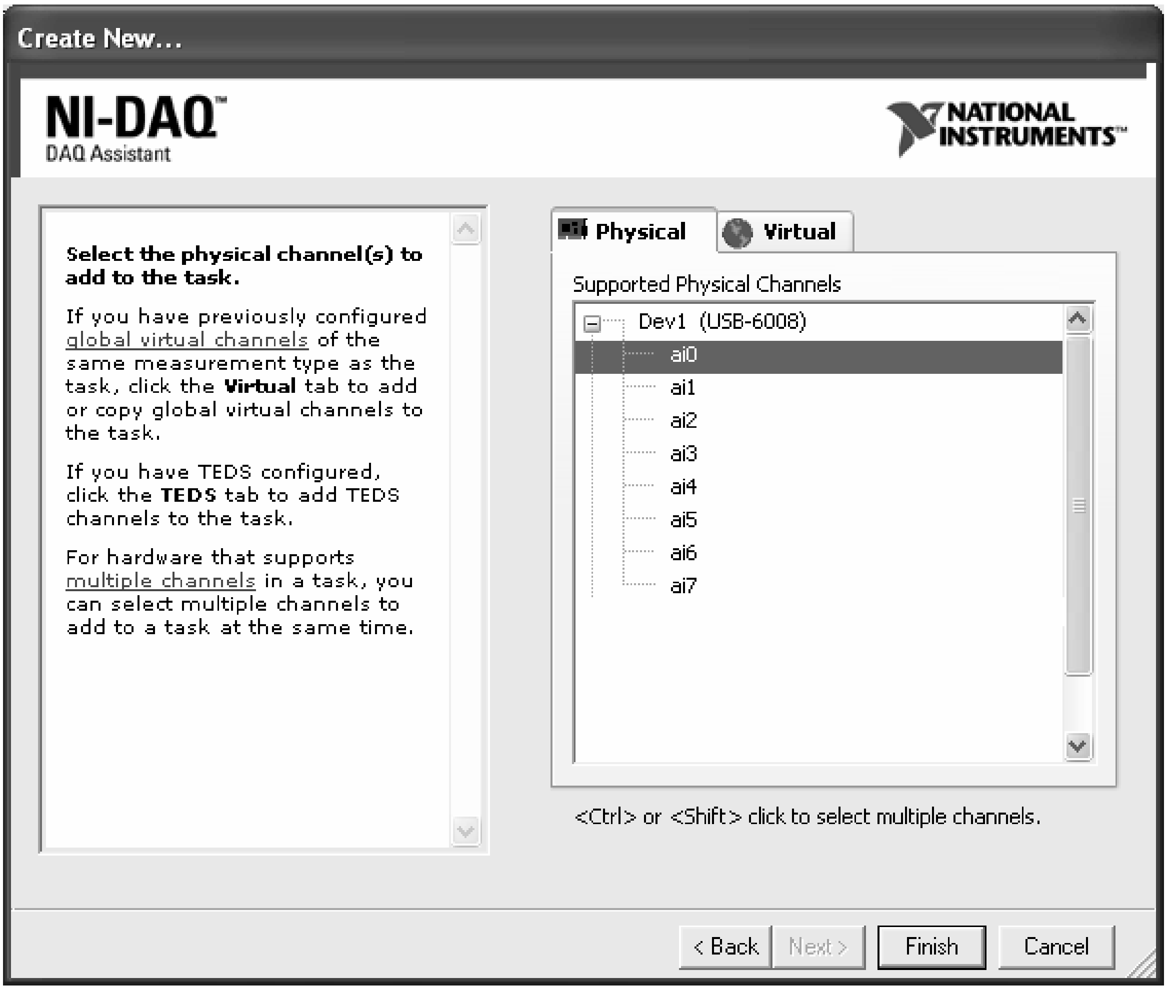


A configuration window should appear. Make the following selections.

Measurement Type: **Analog Input»Voltage**

Channel: **Dev1 (USB-6008 or USB-6009)»ai0**

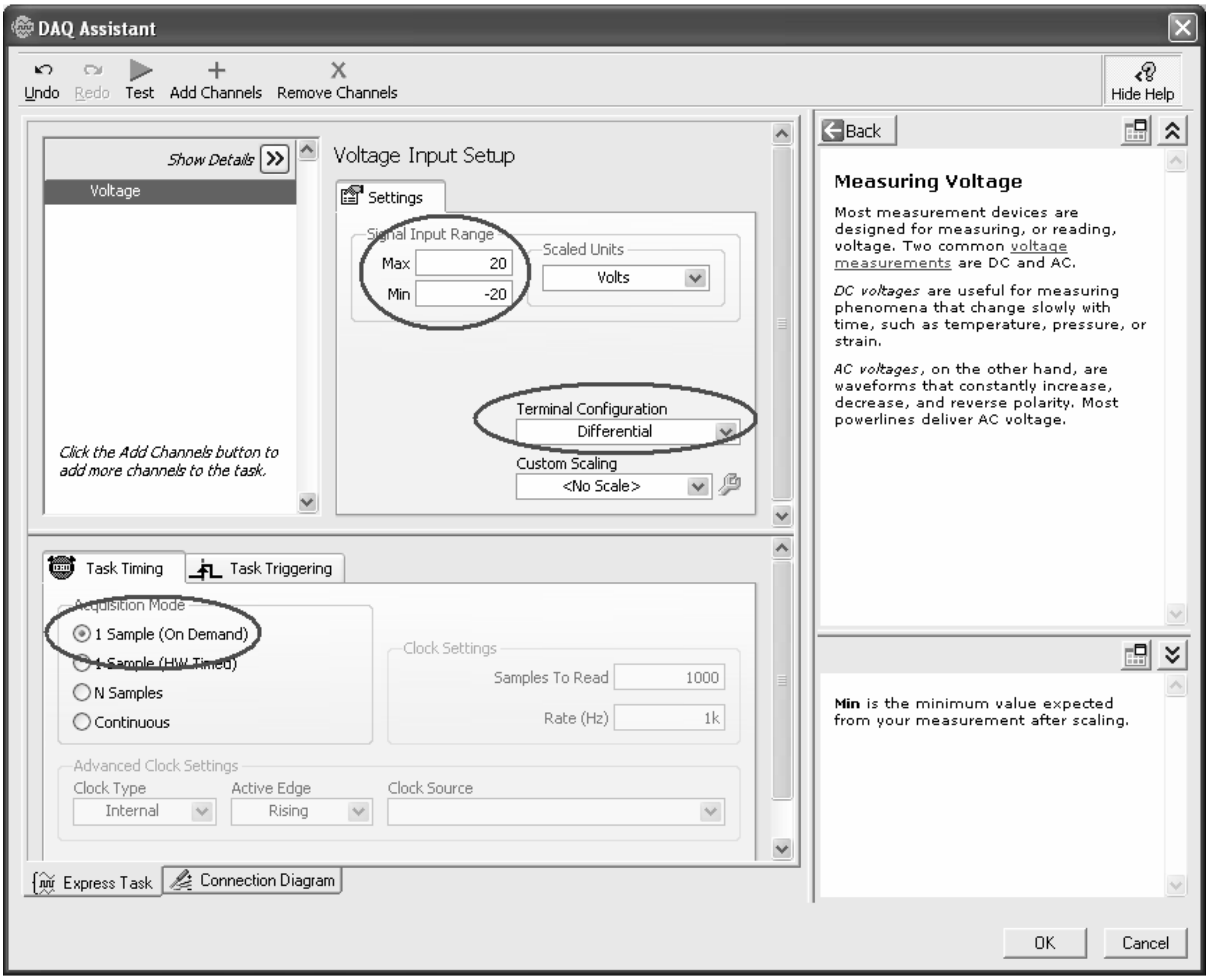
Click **Finish**



10. Another configuration window will appear. Make the following selections and click **OK**.

    Task Timing: Acquisition Mode: 1 Sample (On Demand)

    You may also change the Signal Input Range or Terminal Configuration here.



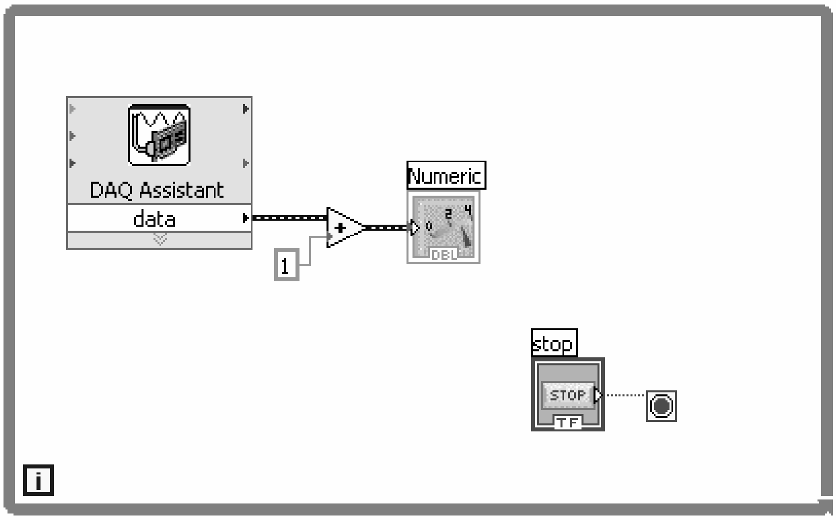
11. Add the following elements to the block diagram:

    11a. Put a **ADD** function (**Express>>Arithmetic & Comparison** >> **Numeric**) on the block diagram. You may in future use any other type of function depending on your application.

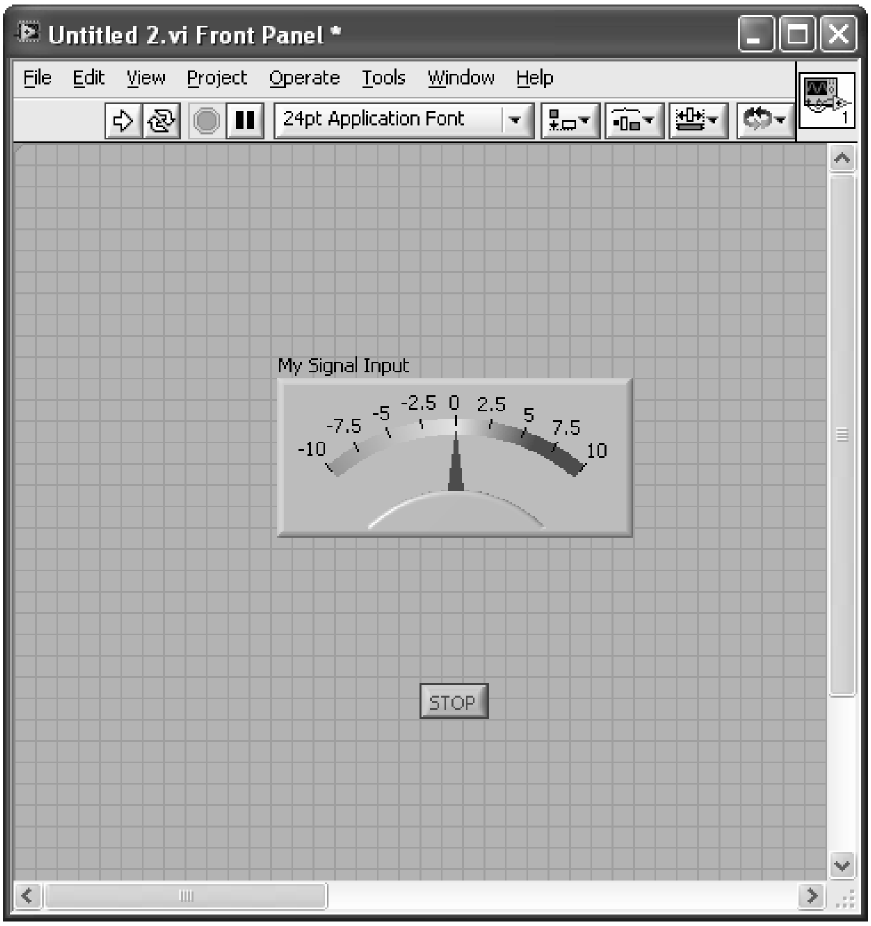
    11b. Put a **Numeric Constant** (**Express>>Arithmetic & Comparison** >> **Numeric**) on the block diagram. Double click on the numeric constant and change the value to 1. We are now adding in a software OFFSET of 1V (just to do some simple arithmetic on the original voltage)

    11c. Right click on the output terminal of the ADD function and choose **Create** >> **Numeric Indicator**.

12. Position and wire the elements to resemble the following:



13. Rather than displaying our data in a numeric indicator, we want to display our temperature readings in a thermometer indicator. To do this, go to the Front Panel by pressing <Ctrl-E>. Right-click the graph indicator and select **Replace**. The Controls palette will appear. Select **Express»Numeric Indicators» Meter**. The Meter indicator should now appear instead of the normal numerical indicator.

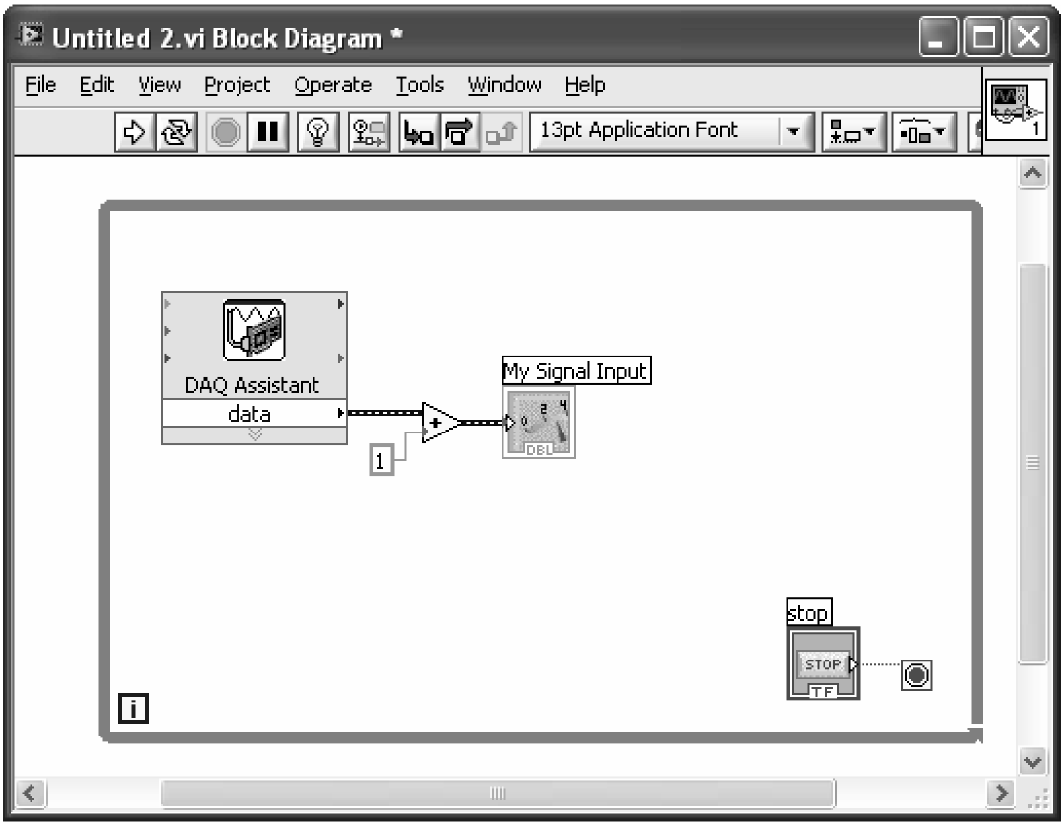


14. Modify the Meter indicator by right-clicking it and selecting **Properties**. On the Appearance Tab, change the **Label** to **My Signal Input**.

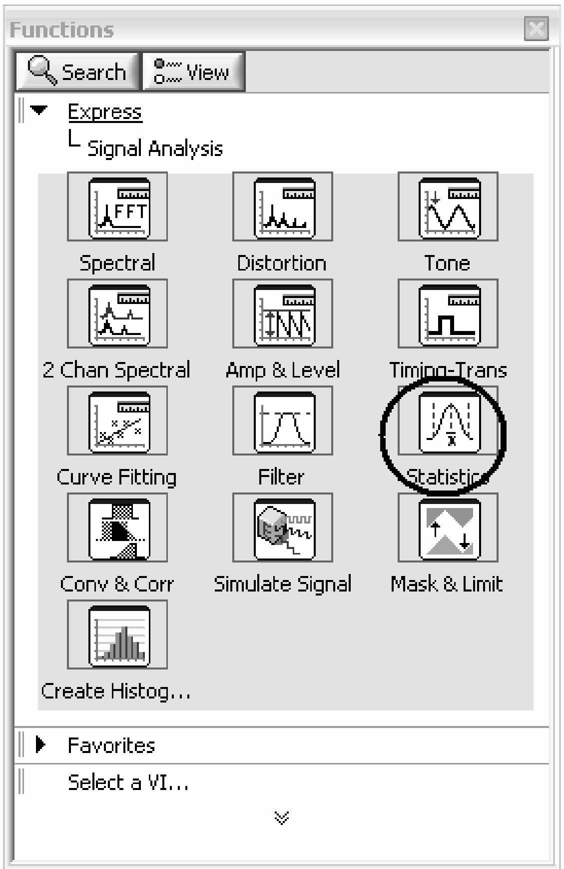
    On the Scale tab, change the **Minimum** to **-10** and the **Maximum** to **10**.

    Click **OK** when you are finished.

15. Switch to the Block Diagram by pressing <Ctrl-E>. Your Block Diagram should now resemble the following illustration. We have just set the My Signal Input to be equivalent to the voltage of the signal which we are trying to measure and added in a fix offset of 1. This offset of course is NOT really required. The purpose of the offset in this exercise is to show you that you can perform any arithmetic function on the original signal you are trying to measure.



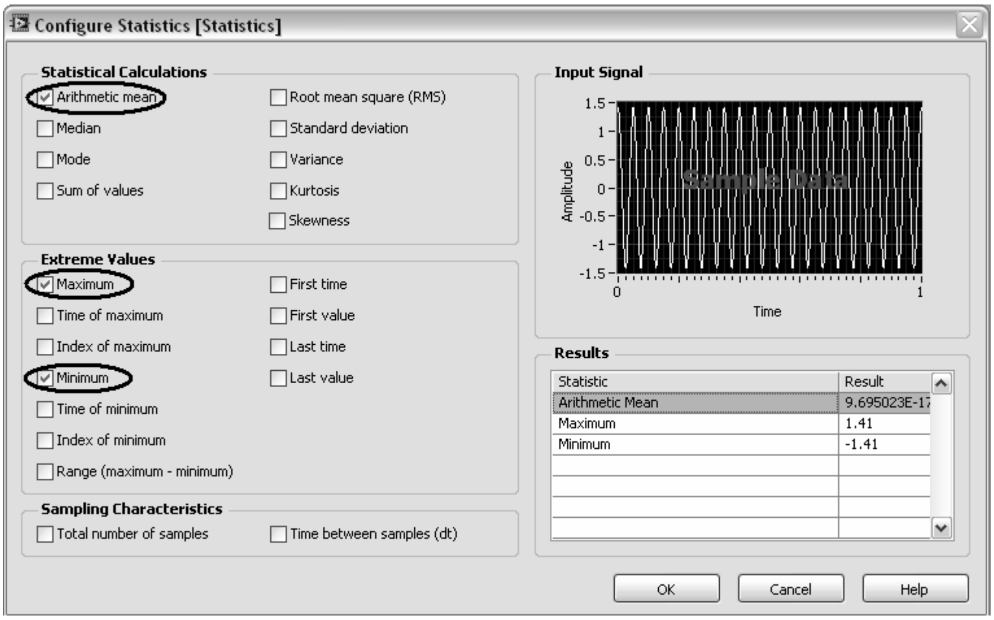
16. To perform analysis on your data, select the **Statistics** Express VI from the **Express>>Signal Analysis** subpalette of the Functions palette and place it on your Block Diagram.



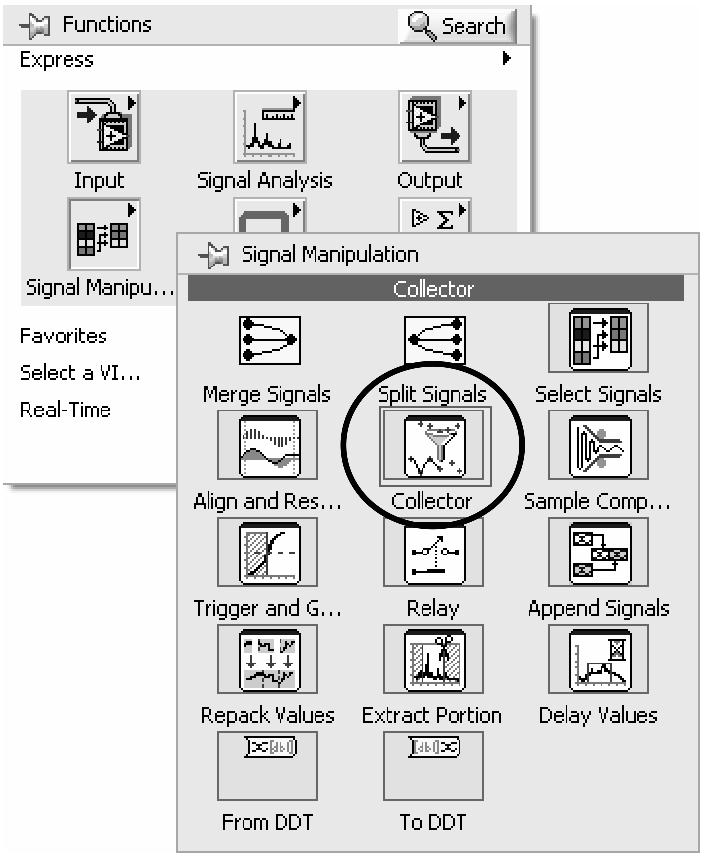
A properties window will appear. Make the following selections and click **OK**.

Statistical Calculations: Arithmetic Mean

Extreme Values: Maximum, Minimum



17. Currently you are collecting one temperature reading each time the While Loop executes. To calculate the average, maximum, and minimum of 100 measurements, place the **Collector** Express VI, located on the **Functions»Express»Signal Manipulation** palette, on the Block Diagram. This Express VI creates an internal buffer to store the individual data points. When the maximum number of inputs is collected, the Express VI discards the oldest points and adds the newest points.



18. In the **Configure Collector** dialog box that appears, set the **Maximum number of samples** to `100`. Click the **OK** button to close the dialog box.

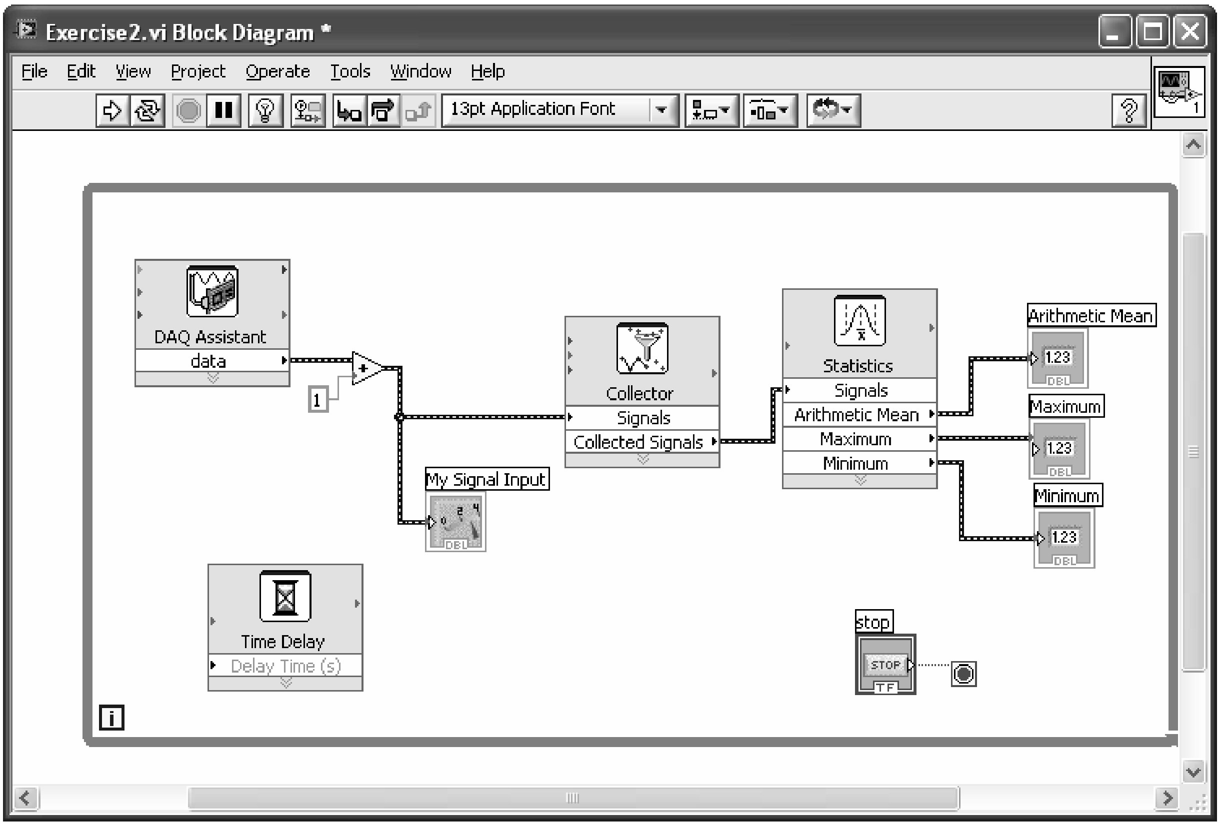
19. Place the **Time Delay** Express VI, located on the **Functions»Express»Execution Control** palette, on the Block Diagram. In the **Configure Time Delay** dialog box that appears, type `0.5` and click **OK** to close the dialog box. This will cause the loop to execute every 500 ms.

20. Make your Block Diagram resemble the following by completing the following steps.

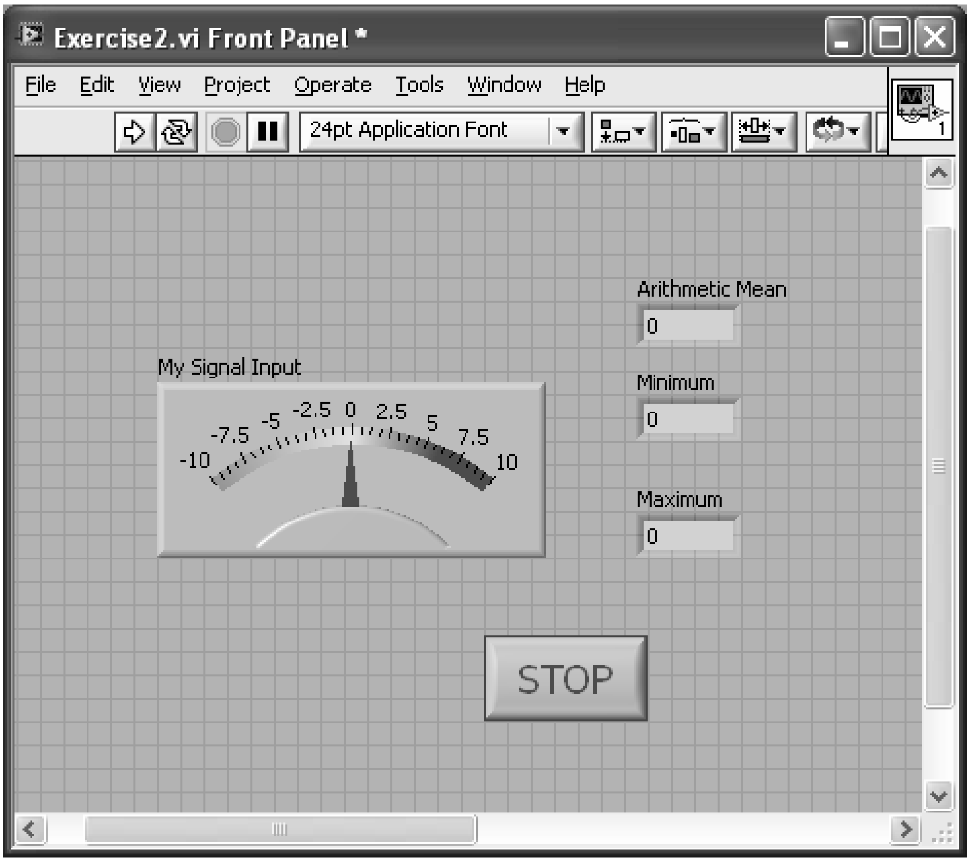
    a. Wire the data output of the multiply VI to the Signals input of the Collector VI.

    b. Wire the Collected Signals output of the Collector VI to the Signals input of the Statistics VI.

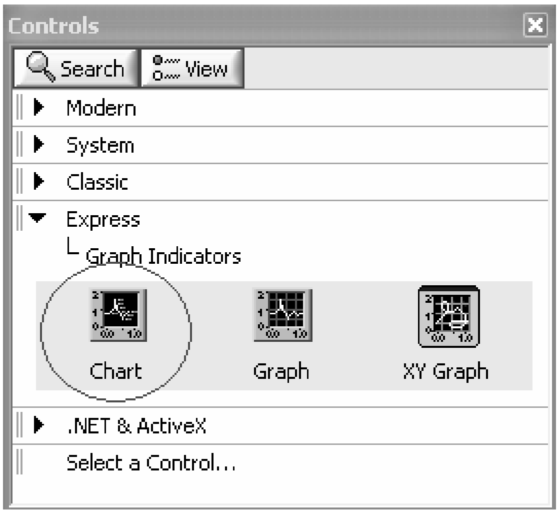
    c. Right-click the Arithmetic Mean output of the Statistics VI and select **Create»Numeric Indicator**. This will create a numeric indicator on the Front Panel that will display the Arithmetic mean. Repeat this step for both the Maximum and Minimum outputs of the Statistics VI.


Exercise2.vi Block Diagram *
File Edit View Project Operate Tools Window Help
13pt Application Font
DAQ Assistant
data
1
Collector
Signals
Collected Signals
My Signal Input
Statistics
Signals
Arithmetic Mean
Maximum
Minimum
Arithmetic Mean
Maximum
Minimum
Time Delay
Delay Time (s)
stop
STOP

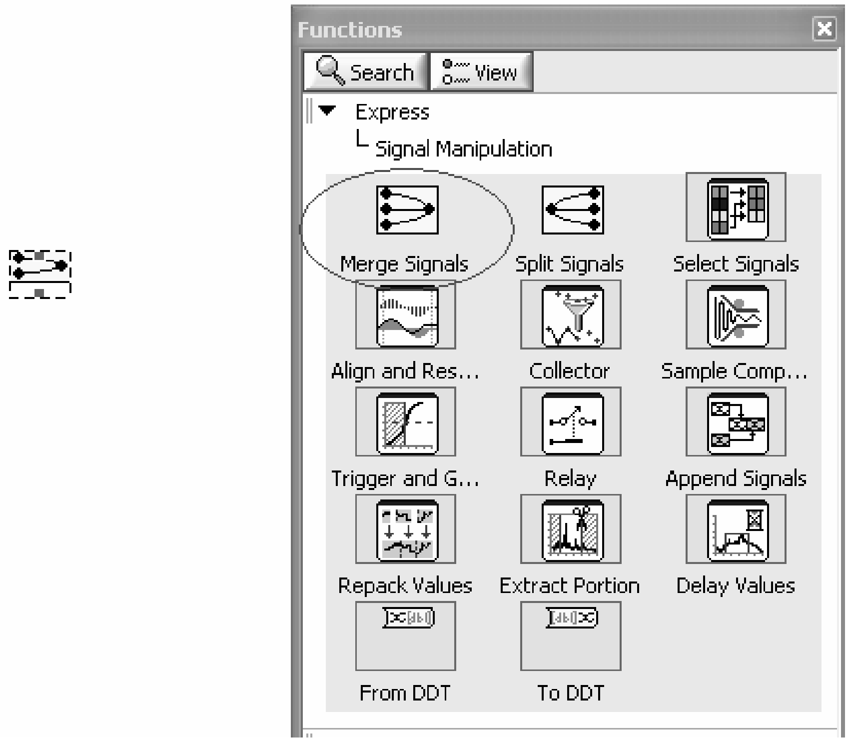
21. Switch to the Front Panel and rearrange your controls and indicators to resemble the following.



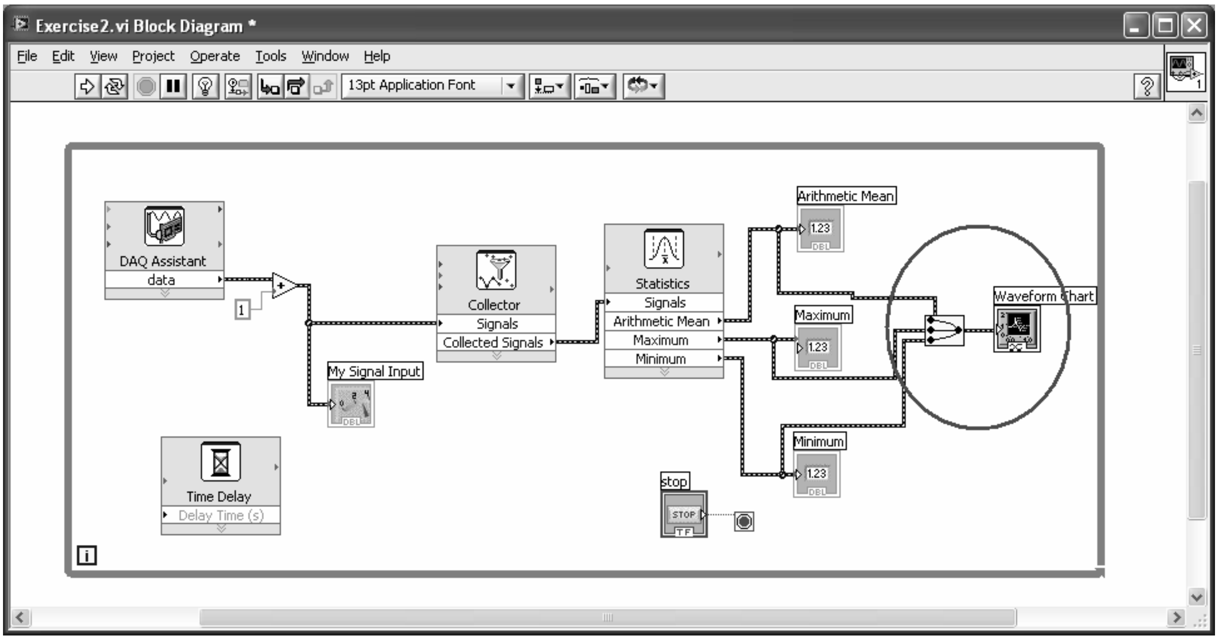
22. Add a waveform chart to the front panel. Right click on the front panel and select the **Waveform Chart** under **Express»Graph Indicators»Chart** and put in on the front panel.



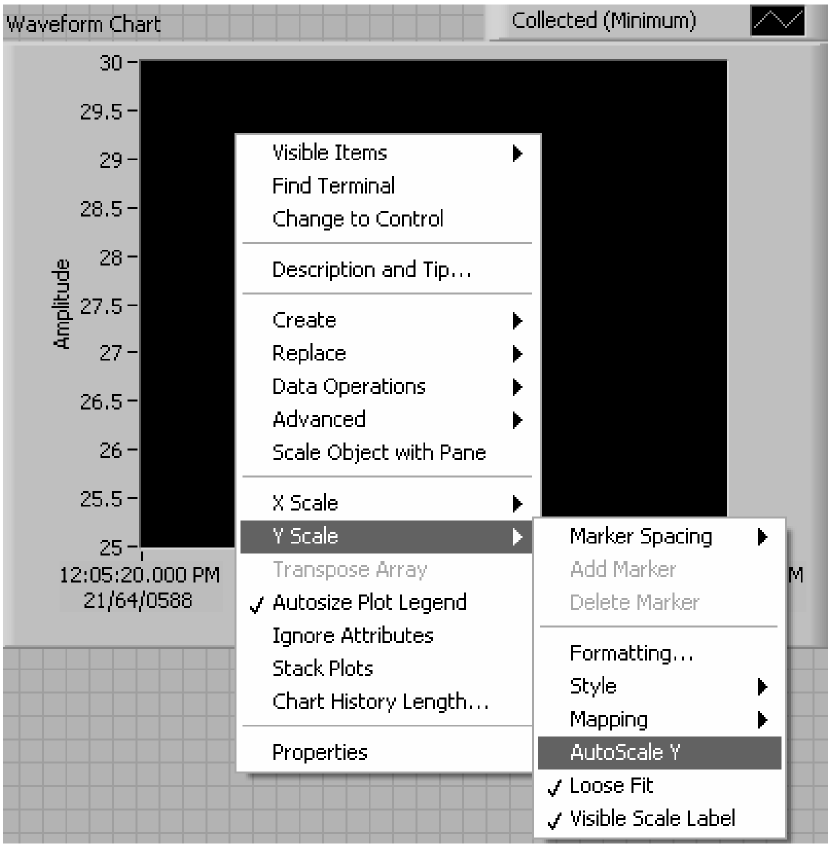
23. Switch to the block. Right click on the block diagram and select the **Merge Signals** under **Express»Signal Manipulation.** Once you drop it to the block diagram, resize the Merge Signals to merge 3 signals.



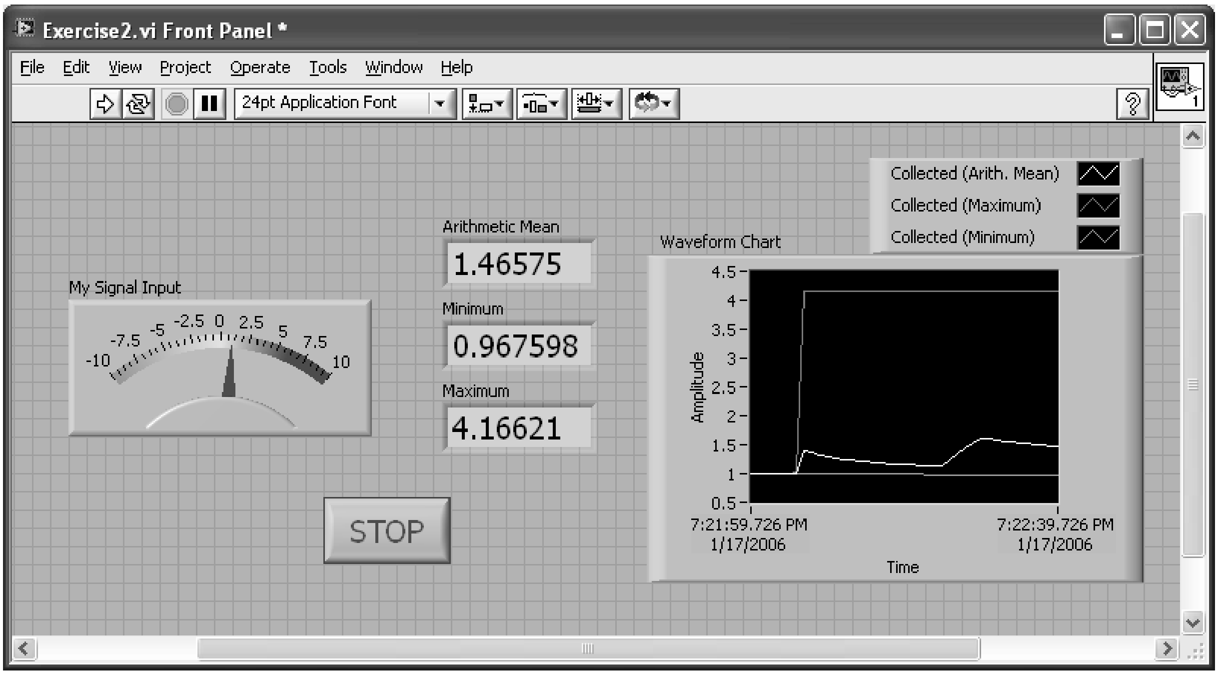
24. Make the following connections.



25. Switch to the front panel by pressing <CTRL-E>, right-click on the Chart and make sure AutoScale Y is unchecked. Change the Y scale of the chart to a minimum of **-10** and maximum of **10**.



26. Run the VI. The front panel should look something like the following. To make the signal noisy you may want to fiddle with the connection to the signal. If the signal is fastened properly to the USB-6008/9, all your signals should be flat. Notice the Offset of 1 V (remember our software offset?)

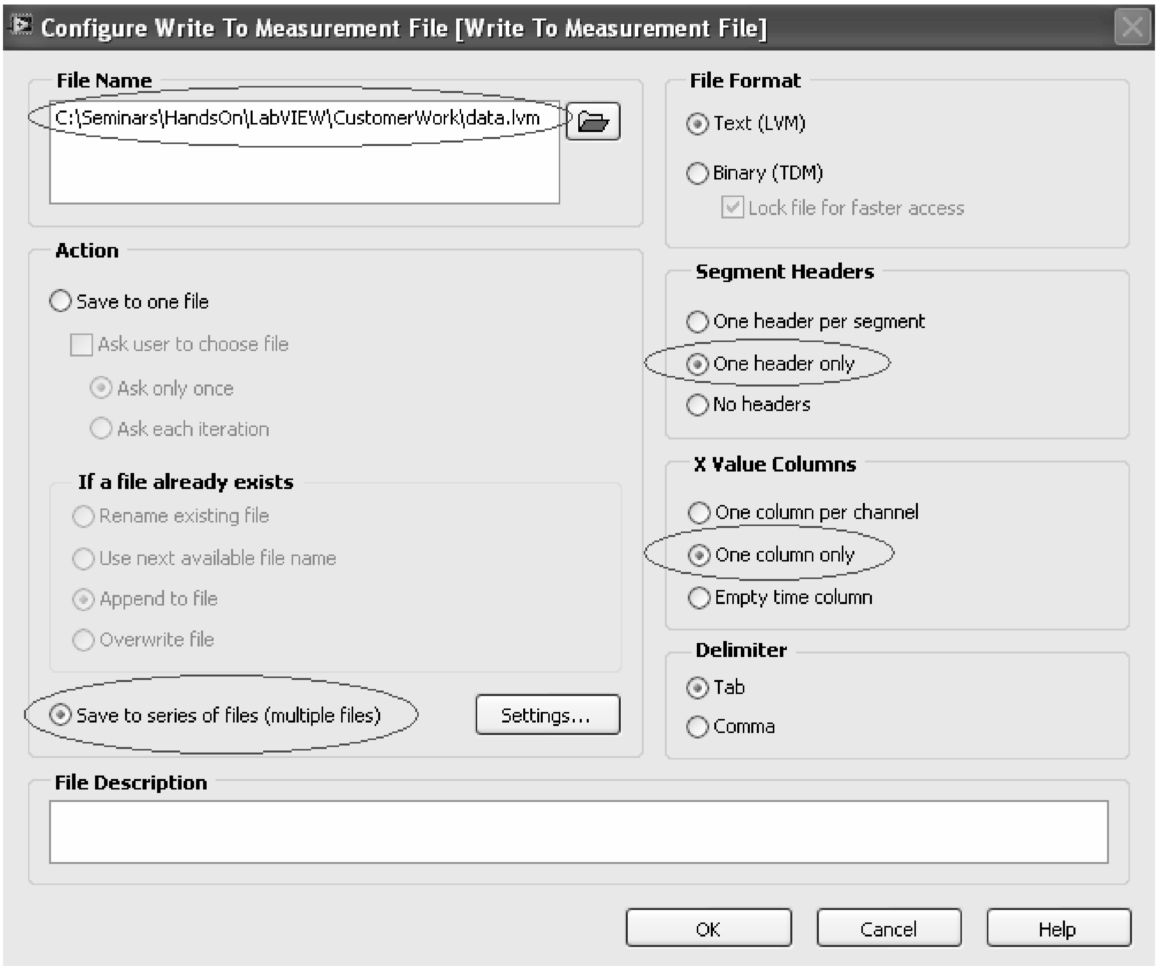


27. Save the VI in the `C:\Seminars\HandsOn\LabVIEW\CustomerWork` folder by using the File menu and name it `Exercise2.vi`.

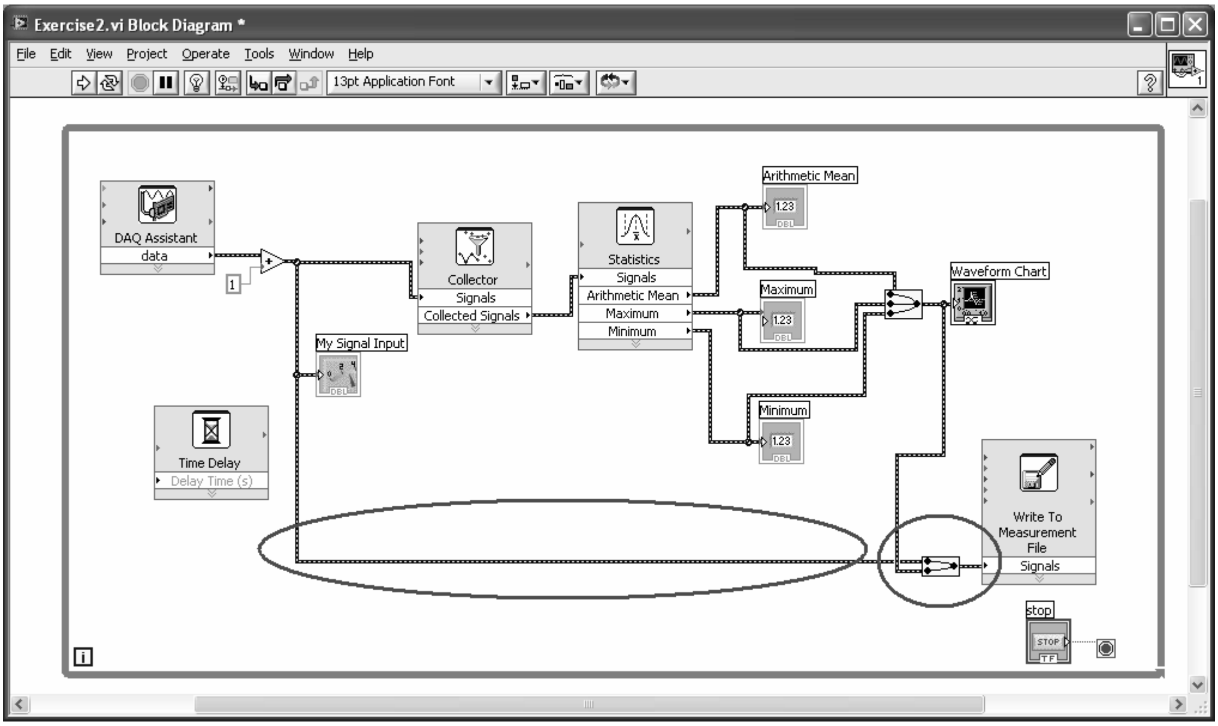
28. Click the **STOP** button on the Front Panel.

29. Right-click on the block diagram and select **Express» Output» Write to Measurement File** and place it inside the While Loop on the block diagram

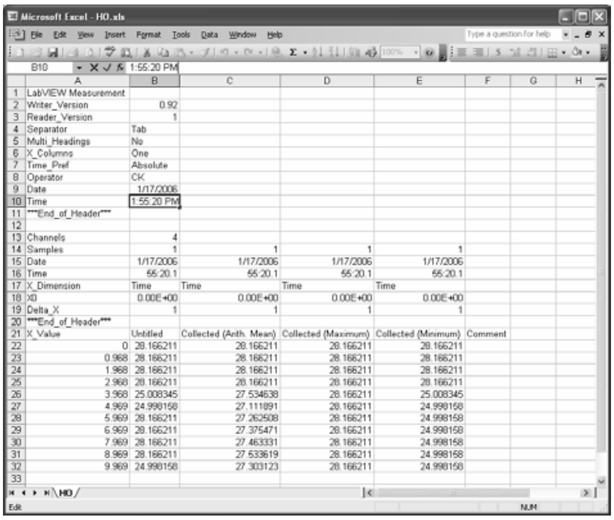
30. A configuration window will appear. Enter the following parameters and click **OK.**



31. Make the following connections. Note that there will be 4 signals saved to the file. The 1st channel to save to file is from the USB-6008/9 channel 0 and the 2nd channel to save is a combination of 3 channels consisting of Mean, Max and Min.



32. Run the VI momentarily and Stop it. Browse to the path that you have set earlier and open the file with a spreadsheet program (eg. Microsoft Excel). You should see properly time-stamped data. Your data should correspond to the data that you have logged earlier.



Microsoft Excel - HO.xls

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	A	B	C	D	E	F	G	H
1	LabVIEW Measurement							
2	Writer_Version	0.92						
3	Reader_Version	1						
4	Separator	Tab						
5	Multi_Headings	No						
6	X_Columns	One						
7	Time_Pref	Absolute						
8	Operator	CK						
9	Date	1/17/2006						
10	Time	1:55:20 PM						
11	***End_of_Header***							
12								
13	Channels	4						
14	Samples	1	1	1	1			
15	Date	1/17/2006	1/17/2006	1/17/2006	1/17/2006			
16	Time	55:20.1	55:20.1	55:20.1	55:20.1			
17	X_Dimension	Time	Time	Time	Time			
18	X0	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
19	Delta_X	1	1	1	1			
20	***End_of_Header***							
21	X_Value	Untitled	Collected (Arith. Mean)	Collected (Maximum)	Collected (Minimum)	Comment		
22	0	28.166211	28.166211	28.166211	28.166211			
23	0.968	28.166211	28.166211	28.166211	28.166211			
24	1.968	28.166211	28.166211	28.166211	28.166211			
25	2.968	28.166211	28.166211	28.166211	28.166211			
26	3.968	25.008345	27.534638	28.166211	25.008345			
27	4.969	24.998158	27.111891	28.166211	24.998158			
28	5.969	28.166211	27.262508	28.166211	24.998158			
29	6.969	28.166211	27.375471	28.166211	24.998158			
30	7.969	28.166211	27.463331	28.166211	24.998158			
31	8.969	28.166211	27.533619	28.166211	24.998158			
32	9.969	24.998158	27.303123	28.166211	24.998158			
33								

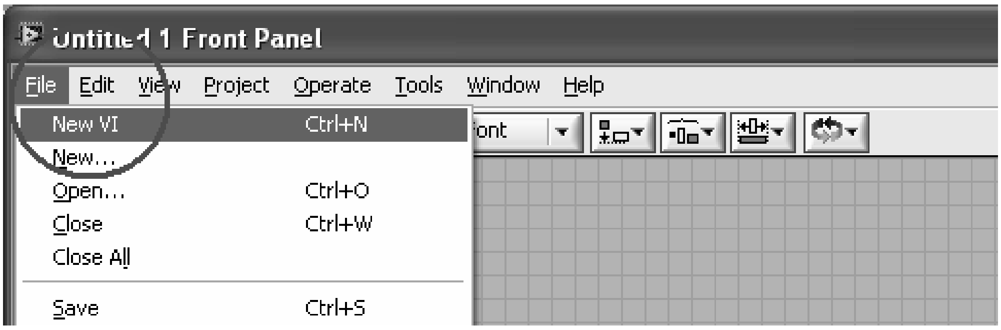
33. Save your VI.

End of Exercise 2a

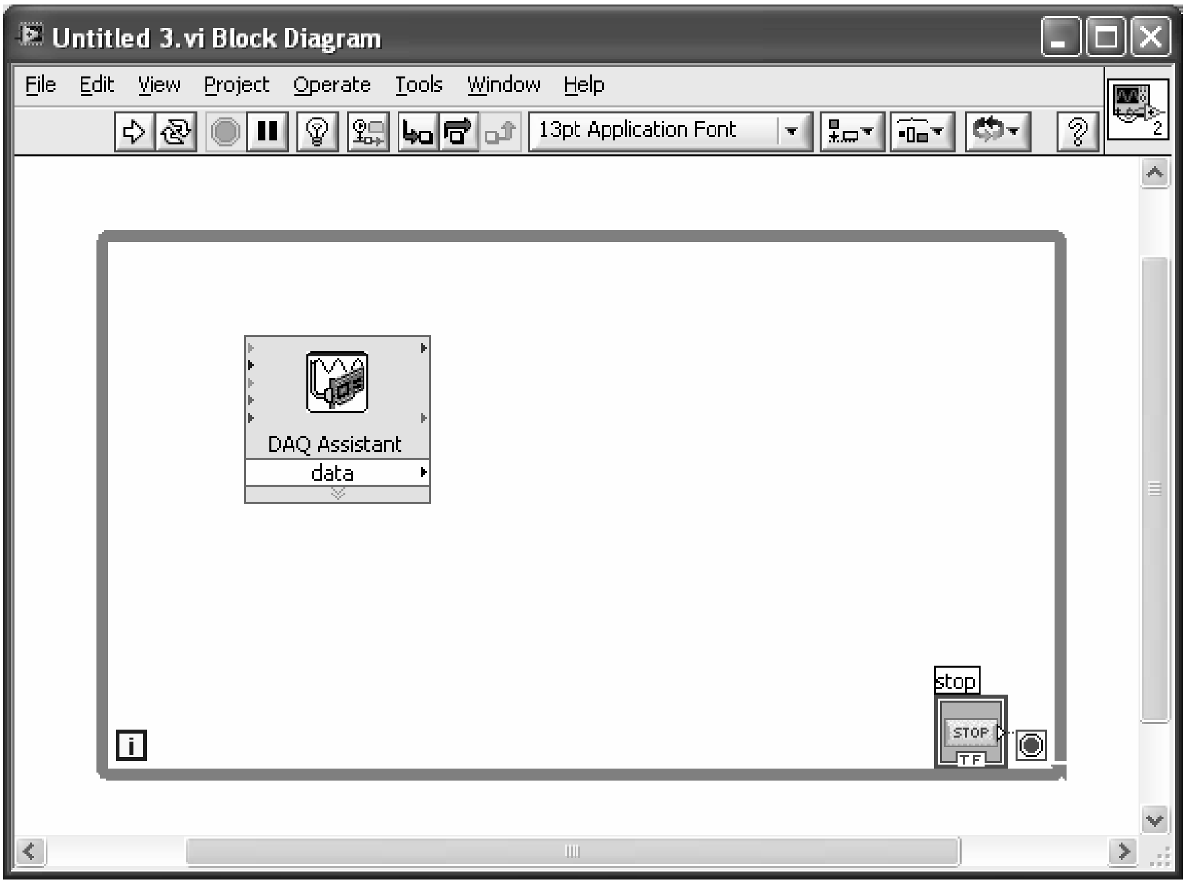
Exercise 2b: High Speed Data Acquisition in LabVIEW

In the previous exercise, our sampling rate is only 2Hz because we have chosen a delay of 500ms in the loop. We will now attempt to sample at a higher rate of 10kHz. The USB-6009 can go up to 48kHz on 1 channel. For multiplex samples, you will have to divide by the number of channels you have selected.

1. Start a brand new VI by going to the Menu and Clicking on File>>New VI.



2. Build the following Block Diagram.

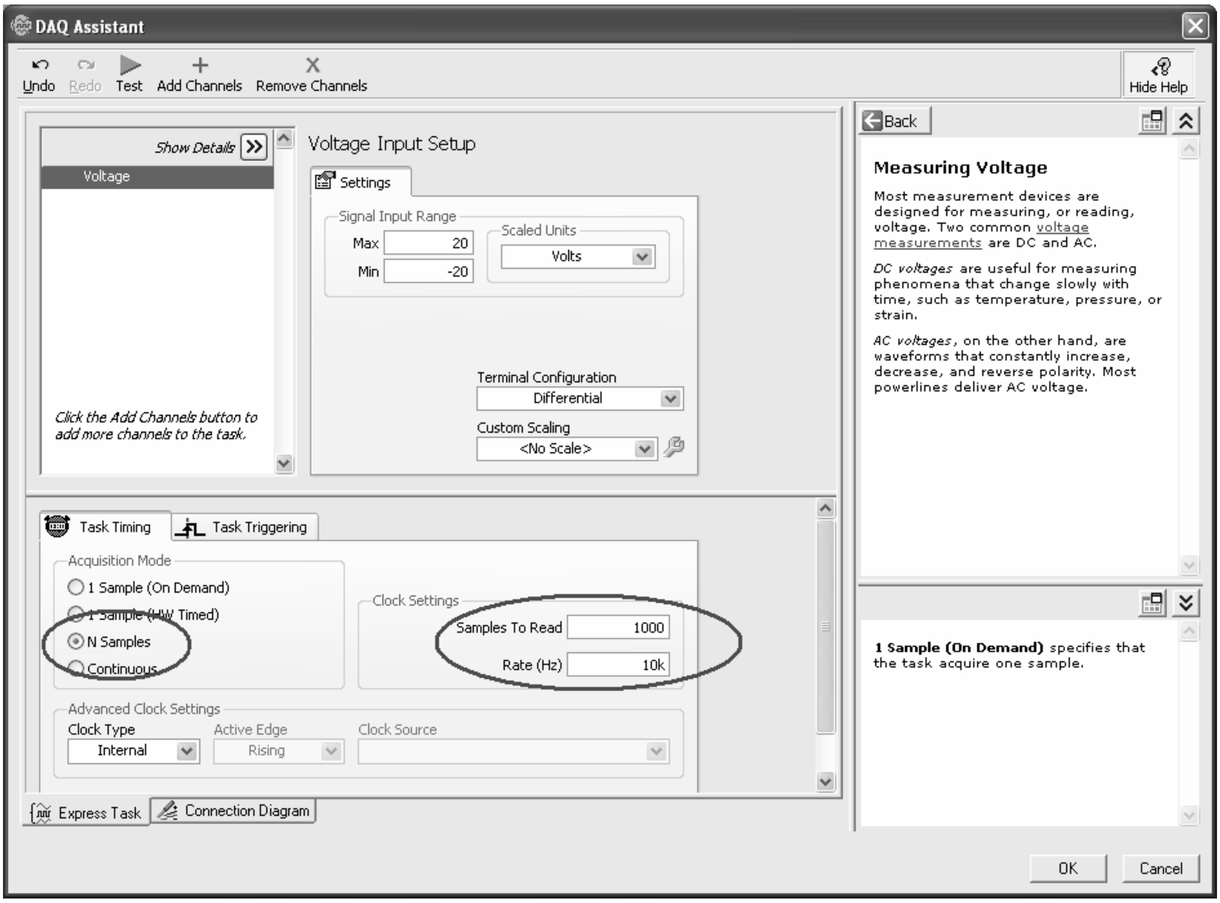


3. This time for the DAQ Assistant, use these settings instead.

Acquisition Mode : N Samples

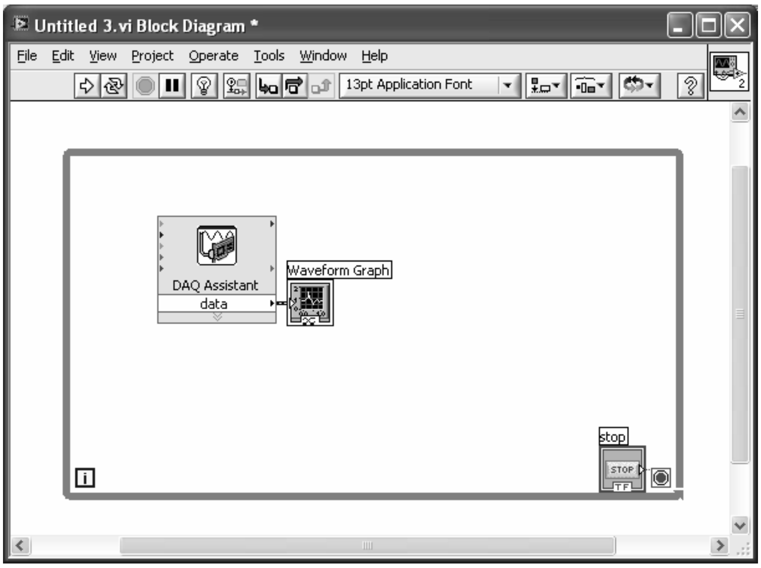
Clock Settings: Samples to Read = 1000, Rate (Hz) = 10kHz

You are configuring the DAQ to sample at 10 kHz and return you 1000 data points on each run. i.e. the time for each run will be 10k/1000 = 0.1 sec.



4. Click OK to return to the Block Diagram and add in the Graph. The Graph can be automatically created by Right-Clicking on 'data' terminal and select Create Graph Indicator. This time we select Graph instead of Chart (as in previous exercise) because we are expecting 1000 samples to be plotted per channel per loop.

   Previously, we are expected only 1 sample per channel per loop so the Chart will be fine.



5. Run the VI and you should see an oscilloscope type of Display in real-time. Notice also that the data intervals are now smaller. We have now an interval of 0.1ms between data. 1000 points will give us 0.1 sec worth of data.